3. Mandibles falciform, with the inner margins smooth, but presenting impressions of denticulations; outer margins with a projecting haft (*contre-fort*).
   A. erythrinus; A. falcarius; A. Manticorus.

4. Mandibles falciform, with the inner margins denticulated, and with no projecting haft on the outer margins.
   A. Trigli; A. Scarites; A. Lupi; A. rapax; A. verrucosus.

XLV.—*On the Fecundation and Development of* Marsilea. By Dr. HANSTEIN*.

WHEN the task was set me of reporting to the Academy upon the capability of development of the so-called *Nardoo-fruits* (the capsules of an Australian species of *Marsilea*), and upon the processes observable in it, I was unable to trace either the fecundation or the development of the germ-plant upon the few fruits first sent by Alexander Rose, as nearly all the prothallia remained unfertilized. Since then I have succeeded in repeated sowings, for which fruits sent by Mr. Osborne, of Melbourne, and by Dr. Ferdinand Müller, of the Botanic Garden at that place, were employed, in witnessing the reproduction and germination of this genus, which were previously unknown.

About four hours after the micro- and megaspores have escaped into the water in the manner formerly described by me†, and issued from their sporangia, the first alterations are perceptible in them. In the small androspores the contents, of starch and proteine-substance, have then formed a more homogeneous plastic mass, and become somewhat contracted all round from the margin, leaving only a few granules on the latter. This mass is then quickly divided, by three planes of segmentation perpendicular to each other, into eight equal parts, and each of these is immediately broken up in two directions, different from each other and from the previous directions of division, into four parts, disposed in relation to each other in the manner of the angles of a tetrahedron. In this way thirty-two equal portions of protoplasm are produced by an act of division which resembles the process of segmentation in the animal ovum; and it is only after the completion of this that a cell-membrane is formed around each of them.

In each of these thirty-two cells, which retain their regular arrangement, a spermatozoid is developed. The four spermatozoids of each tetrahedral group lie in the approximated halves of

* Translated by W. S. Dallas, F.L.S., from the 'Monatsbericht der Akademie der Wissenschaften zu Berlin, August 1864, p. 576.

† Monatsber. Berl. Akad. 1863, p. 414.

the four cells. The process is completed in from eighteen to twenty-two hours. Soon afterwards the solid exosporium of the androspore breaks up, and the contents enclosed by the delicate inner membrane escape; the contents either burst the membrane during their escape, or form a transparent spherule from which the daughter cells issue by degrees and set free the spermatozoids.

These have previously been in whirling motion; they burst their mother cells singly, and hurry from them with the rapidity of an arrow. Each spermatozoid consists of a corkscrew-like filament, to the last remarkably large turns of which a large globular vesicle adheres; the latter contains numerous starch-granules in a clear fluid, and resembles an independent cell surrounded by a sufficiently firm membrane. This is by no means a part of the mother cell, which, on the contrary, remains behind empty after the escape of the spermatozoid. The screw-like filament has twelve or thirteen turns; it is very closely twisted at the apex, and is beset, especially on the lower and wider turns, with numerous very long cilia, which, when bent forwards in swimming, often project beyond the tip of the screw.

In the meantime the prothallium with the archegonium has been developed on the macrospores. Even before the escape of the macrospore, its vertex, inflated in the form of a wart, is filled with yellowish finely granular plasma, while the rest of its space contains the well-known large starch-grains, oil-drops, and proteine substances. Several hours after the escape of the spore, this lentiform mass of protoplasm is still undivided by any perceptible septum from the rest of the inner space of the spore, and is therefore not a complete cell; but in about five or six hours it is cut off by a proper cellulose membrane. Soon afterwards its plastic contents separate into a roundish central principal mass and a peripheral layer which is thicker towards the free upper surface; the latter then gradually divides into smaller and smaller portions, which surround the central mass in a single layer. The cell-body thus sketched out, but not completed, breaks up at the slightest touch; but subsequently first the central and finally the peripheral parts surround themselves with resistant cell-walls, which enter into close mutual connexion.

The central cell is then the primary cell of the nascent archegonium, the mother cell of the germ; the peripheral cells form the prothallium. In the middle of the basal surface the central cell is sometimes in immediate contact with the septum between the prothallium and the interior space of the spore, and is therefore excentric. Exactly at its vertex four regularly placed cells soon exceed the others in size, and rise into a wart, each of them at the same time being divided again by a septum directed from without inwards towards the common point of contact of all the four. By the further elevation of the four upper daughter cells the neck of the archegonium is completed.

At about twenty to twenty-four hours after the escape of the spores, the archegonium is ready for impregnation; and fertilization takes place without being limited to any particular time of the day*. Beneath the vertex of the central cell a portion of colourless mucus separates from its yellowish mass of protoplasm, and fills a somewhat lentiform space below the neck of the archegonium, which frequently appears to be divided by sharp boundary lines from the contracted globular protoplasm†. This mucus swells, presses upwards, bursts out suddenly with a violent explosion between the four pairs of cells of the archegonium, and thus opens the canal of its neck, which then leads from without into the interior of the central cell. The mass thrown out often remains for days unchanged near the orifice.

Of the swarming spermatozoids many are usually already at hand. They do not seek after the entrance in the mucous envelope of the gynospore, but penetrate it where they come upon it. In this process the starch-saccule is an obstacle; by energetic whirlings they get rid of it, and then swim to the orifice of the archegonium, usually with the apex of the screw in front, and then, as before, very rapidly, or in the reversed position, and then more slowly.

Immediately after the expulsion of the mucus, I saw a spermatozoid hasten by, turn the apex of the screw into the orifice, turn rapidly upon its axis for a moment, as if it had to overcome some internal resistance, and then suddenly disappear in the interior of the archegonium, where it was impossible to trace it further, on account of the opacity of the prothallium. In one case two disappeared, one after the other, in the same archegonium. All subsequent ones were rejected, although no hindrance to their admission was observable.

The number of spermatozoids which collect in the mucous envelope of a gynospore often amounts to several hundreds. Whole tufts of them adhere by their points to the orifices of the fertilized archegonia, the necks of which quickly become brown. About the unfecundated specimens those little swarming corpuscles which I formerly mentioned‡ soon occur. But I have

* I have witnessed the swarming of the spermatozoids even about midnight.

† The precise observation of the processes of material change within the central cell is prevented by the imperfect transparency of the prothallium.

‡ Monatsber. Berl. Akad. 1862, p. 114.

now ascertained, by keeping male and female spores separately, that the production of these is not directly dependent upon the spores, but that they occur with both kinds, and even with residues from other parts of the fruit of *Marsilea*. They are Monad-like creatures, which sometimes, like true Monads, swim about briskly, and sometimes, resting, become increased into chain-like series, like certain species of *Vibrio*. The perfect agreement of their form and mode of occurrence in all observed cases is, however, remarkable; and the singular manner in which both these corpuscles and the spermatozoids crowd together in front of the orifices of the archegonia induces the belief that the orifice itself may be the seat of some mechanical cause of motion, although this has hitherto escaped direct observation.

After fecundation, the contents of the central cell contract into a free spheroidal mass, which, like the prothallium itself, has a circular transverse section; by the development of a cell-membrane, this becomes the primitive cell of the germ-plant.

In about twelve hours the division of this commences by the formation of a wall which is nearly perpendicular, if we regard the longitudinal axis of the macrospore to be placed in an upright position. This wall divides it into two somewhat unequal parts, the larger of which becomes developed into the stem, and may therefore be characterized as the anterior portion. Both these parts divide again immediately—the anterior, by a horizontal wall, into two equal parts, and the posterior, by a partition inclined backwards, into two unequal parts. The germ is now apparently divided almost crosswise into four cells, of which the anterior upper one becomes the first leaf, and the posterior upper one the first root. The anterior lower cell is immediately divided again into two cells by a wall starting from the horizontal wall and descending forwards; the upper of these (now the middle one of the anterior three cells) is the primitive cell of the growing bud. The separated lower cell of the anterior side is developed, in common with the lower posterior cell, into a parenchymatous mass, which, as the so-called *foot*, long retains the young germ-plant in the prothallium and on the gynospore. Each of the three other cells proceeds on its own course of development.

Three walls, produced one after the other, following the outline of the cell in their position and curvature, and directed towards each other internally, cut off from the primitive root-cell an apical root-cell in contact with the boundary of the germ posteriorly and superiorly; and in this the peripheral side speedily separates, in the form of a cap-like outer cell, from an inner one of a three-sided pyramidal shape. The former is the first cell of the pileorhiza. It first divides crosswise into four contiguous superficial cells, and then continues dividing, sometimes by transverse and sometimes by longitudinal walls. The inner cell, which is now the true apical root-cell, proceeds to separate lateral cells of division alternately in three directions, which likewise originate the very uniform tissue of the root by longitudinal and transverse septa. At first, however, this process takes place very slowly.

The most rapid progress is made by the first leaf. Its primitive cell is first broken up, simultaneously with the two subjacent cells of the anterior half of the germ, into two equal lateral halves, in a plane standing perpendicular to the first three divisional walls. In both, the further division takes place by the production of divisional walls alternately from above and from the front, tending towards each other internally, separating discoid cells from the apical cell, which is rising forwards and upwards. In this way the leaf soon acquires a conical form, constantly becoming more acute, which finally passes, by the repeated extension and division of the cells of the second and third order, into the filamentous form, which the first leaf retains.

The evolution of the bud takes place but slowly. Its primitive cell is divided by the above-mentioned perpendicular septum into two adjacent cells, which are apparently similar, but are of very unequal value. One of them becomes the second leaf: the other continues to be the apical cell of the incipient axis of the stem; and thus the symmetry of the anterior side of the germ is for the moment destroyed.

In the apical cell, three septa approximating internally, and running nearly parallel to the three lateral walls, separate three more divisional cells—first an upper one, then a lower one, and lastly an inner lateral one adjacent to the second leaf: they leave the apical cell diminished between them, and are developed from no independent parts. The axis of the apical cell, which is now of a three-sided pyramidal form, furnished with a strongly arched basal surface directed forward, now exactly indicates the direction of the further development of the stem-bud. A seventh septum, running similarly to the fourth, but more strongly curved downwards on the side opposite to the second leaf, and cutting off a larger daughter cell, gives origin to the third leaf, which consequently makes its appearance opposite to the second, and restores the symmetry of the bud.

Next trimerous cycles of interstitial cells issue from the apical cell, corresponding to its three walls, until the fourth and fifth leaves are produced from it in the same direction and in the same manner as the second and third. No law could be discovered for the number of these interstitial cells, which rapidly increases between the first leaves. The increasing covering of the bud with hairs, and the liability to injury of the young vegetative point, render the observation of the further development difficult. But all the facts hitherto observed go to prove that the apical cell continues its further evolution in the same fashion, even in the growing stem-bud of the old plant. The leaves always appear exactly bipartite, somewhat approximated on the upper side of the horizontal axis. It is consequently to be supposed that all of them, like the first, originate only from the cells of the two upper series which proceed from the apical cell, whilst the third series only furnishes the commencement of roots and internodial cells.

This whole process of cell-division therefore shows that the first perpendicular wall divides the germ into the primitive cells of the stem and root, and that the ideal primary axis of the free germ is consequently to be regarded as horizontal. From the stem-cell the first septum separates the first leaf, which has the import of a cotyledon. The second furnishes a piece which, as it only forms, in common with a divisional cell of the root of the same order, a parenchymatous body situated laterally to the axis, must be regarded, not as a metamorphosed leaf, but as an internodial part, like many which subsequently issue from the apical cell of the stem alternately with the foundation-cells of the leaves. Consequently the first root also, which lies exactly in the line of the posterior extension of the main axis of the stem, acquires the position and direction of a main root. On the contrary, the view that the foot is essentially the aborted primary axis, and that the first root and first bud are only adventitious organs, is supported neither by the position nor by the sequence of the septa in and between the constituent foundation-cells of the germ.

The first germ-leaf is situated in the median line of the germ, the subsequent ones to each side. Between the first and second leaves the divergence is about $= \frac{1}{4}$; the rest follow under a divergence. of $\frac{1}{3}$, whilst the spiral continually becomes closer. On the other hand, the division of the apical cell itself passes rapidly into an homodromous spiral with a divergence of $\frac{1}{3}$. After the second leaf the cell-multiplication no longer commences with a perpendicular septum, but rather with walls directed towards each other laterally. Their development is similar to that known to occur in other Fern-leaves. They gradually attain to a greater extension, which only reaches its term about the tenth or twelfth leaf.

The prothallium follows the development of the germ itself by an independent growth, moulding itself upon the form of the germ. At last the rapidly growing leaf bursts it above, and the root subsequently beneath. The root then penetrates into the soil, the prothallium having been fastened to the surface by its rootlets. The foot beneath is intimately adherent to the tissue of the prothallium, and stretches over the upper opening of the spore, for the purpose of taking up its nutritive material and handing this over to the other parts of the germ. The young bud remains long concealed; but when it subsequently breaks out, the cast remains of the prothallium perish.

The more particular description of the entire process of development, especially the cell-division of the germ, the appearance of the vascular bundles and of the later roots, and the evolution of the leaves, will shortly be published, with the necessary figures, in Pringsheim's 'Annalen.'

XLVI.—*Diagnoses of new Forms of Mollusca from the Vancouver District.* By Philip P. Carpenter, B.A., Ph.D.

The shells here described were mostly collected by Indian children for their excellent teacher Mr. J. G. Swan, in the neighbourhood of Neeah Bay, W. T. They were presented by him to the Smithsonian Institution, Washington, D.C.; and, in accordance with their liberal policy, the first available duplicates will be found in the British Museum or in Mr. Cuming's Collection. The species are numbered to correspond with the list in the British Association Report for 1863, pp. 626–628; see also pp. 636–664.

5. *Mæra salmonea.*

M. testa parva, solida, compacta, subquadrata; lævi, nitente, epidermide tenui cinerea induta; extus pallide, intus vivide salmoneo tincta; marginibus dorsalibus rectis, ad angulum 120° separatis, umbonibus haud extantibus; marginibus antico et ventrali regulariter late excurvatis; parte postica brevissima, haud angulata: intus, dent. card. utraque valva ii., quorum unus bifidus; lateralibus v. dextr. æquidistantibus, ant. extante, post. parvo; nymphis rectis, haud conspicuis; cicatr. add. post. subrotundata, ant. subrhomboidea; sinu pallii satis regulariter ovali, per iv. inter v. partes interstitii porrecto. Long. ·57, lat. ·45, alt. ·11 poll.

Variat testa aurantiaca, rarius albida, rosaceo tincta.

Hab. San Francisco (*Pac. Rail. E. E.*); Neeah Bay (*Swan*), plentiful; Monterey, 20 fathoms (*Cooper*).

In shape almost close to *Macoma crassula*, Desh. (Arctic); but that species is thinner, not glossy or salmon-coloured, and has no lateral teeth.

6. *Angulus variegatus.*

A. testa forma *A. obtuso* simili, sed costa interna omnino carente, valde inæquilaterali, solidiore, nitente, rosaceo et flavido subradia-